

SOLAR OBSERVATIONS

[Meteorological Research Division, EDGAR W. WOOLARD in charge]

SOLAR RADIATION OBSERVATIONS, APRIL 1940

By DAVID HABER

Measurements of solar radiant energy received at the surface of the earth are made at nine stations maintained by the Weather Bureau, and at ten cooperating stations maintained by other institutions. The intensity of the total radiation from sun and sky on a horizontal surface is continuously recorded (from sunrise to sunset) at all these stations by self-registering instruments; pyrheliometric measurements of the intensity of direct solar radiation at normal incidence are made at frequent intervals on clear days at three Weather Bureau stations (Washington, D. C., Madison, Wis., Lincoln, Nebr.) and at the Blue Hill Observatory at Harvard University. Occasional observations of sky polarization are taken at the Weather Bureau stations at Washington and Madison.

The geographic coordinates of the stations, and descriptions of the instrumental equipment, station exposures, and methods of observation, together with summaries of the data obtained, up to the end of 1936, will be found in the *MONTHLY WEATHER REVIEW*, vol. 65, December 1937, pp. 415 to 441; further descriptions of instruments and methods are given in Weather Bureau Circular Q.

Table 1 contains the measurements of the intensity of direct solar radiation at normal incidence, with means and their departures from normal (means based on less than 3 values are in parentheses). At Madison and Lincoln the

observations are made with the Marvin pyrheliometer; at Washington and Blue Hill they are obtained with a recording thermopile, checked by observations with a Marvin pyrheliometer at Washington and with a Smithsonian silver disk pyrheliometer at Blue Hill. The table also gives vapor pressures at 7:30 a. m. and at 1:30 p. m. (75th meridian time).

Table 2 contains the average amounts of radiation received daily on a horizontal surface from both sun and sky during each week, then departures from normal and the accumulated departures since the beginning of the year. The values at most of the stations are obtained from the records of the Eppley pyrheliometer recording on either a microammeter or a potentiometer.

Direct radiation intensities averaged considerably above normal at Lincoln, somewhat above normal at Washington and Blue Hill, and close to normal at Madison. The March normal incidence radiation intensities at Blue Hill, published as late data, averaged somewhat above normal.

Total solar and sky radiation was decidedly deficient at Washington, Riverside, Blue Hill, and Newport. Considerable excess radiation was received at Madison, Chicago, and Friday Harbor.

Polarization measurements made at Madison on three dates give an average of 60 percent, with maximum of 66 percent on the 20th. Both of these values are close to the April normal.

TABLE 1.—Solar radiation intensities during April 1940

[Gram-calories per minute per square centimeter of normal surface]

WASHINGTON, D. C.

Date	Sun's zenith distance										Local mean solar time
	7:30 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time										
e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e	
m.m.	cat.	cat.	cat.	cat.	0.74	cat.	cat.	cat.	cat.	m.m.	
Apr. 4	7.04	—	—	—	—	—	—	—	—	8.81	
Apr. 6	2.26	—	—	1.23	1.66	—	—	—	—	2.49	
Apr. 10	4.57	—	—	—	.90	—	—	—	—	4.17	
Apr. 11	6.76	—	—	—	—	—	—	—	—	7.04	
Apr. 25	6.02	—	—	—	.82	—	—	—	—	5.16	
Apr. 28	5.36	—	—	—	1.02	—	—	—	—	3.99	
Apr. 29	5.79	—	—	—	—	—	—	—	—	3.15	
Means	—	(.91)	(1.07)	1.01	(1.58)	—	—	—	—	—	—
Departures	—	+.12	+.18	-.06	+.21	—	—	—	—	—	—

MADISON, WIS.

Apr. 1	3.63	0.58	0.79	0.93	0.90	1.32	—	—	—	4.37
Apr. 5	3.15	.96	1.06	1.21	1.38	1.54	1.37	—	—	3.30
Apr. 9	4.17	—	—	1.19	1.26	1.45	—	—	—	4.75
Apr. 12	2.06	—	—	.79	.94	1.08	1.15	1.35	—	2.49
Apr. 13	2.62	.98	1.14	1.30	—	—	—	—	—	2.36
Apr. 18	4.37	—	—	—	—	1.24	—	—	—	5.79
Apr. 19	4.75	—	—	.70	.83	1.04	1.26	—	—	5.36
Apr. 20	3.81	—	—	1.04	1.15	1.34	1.52	—	—	2.87
Apr. 26	4.17	—	—	.91	1.03	1.15	1.40	—	—	4.95
Apr. 27	3.45	.77	.88	.99	1.01	1.38	—	—	—	3.81
Means	—	.82	.93	1.08	1.15	1.40	(1.30)	—	—	—
Departures	—	.00	-.01	+.03	-.06	-.04	+.11	—	—	—

LINCOLN, NEBR.

Apr. 3	3.45	—	—	1.13	1.26	1.42	—	—	—	2.49
Apr. 4	3.16	—	—	1.14	1.25	—	1.60	1.53	1.15	2.87
Apr. 12	1.88	—	—	1.05	—	—	1.68	1.34	—	1.24
Apr. 13	2.62	—	—	1.11	1.33	—	—	—	—	2.36
Apr. 18	3.63	0.83	—	.80	.79	1.00	—	1.24	1.04	—
Means	—	(.83)	—	1.03	1.10	1.25	(1.64)	1.30	(1.10)	(.92)
Departures	—	+.11	+.20	+.12	+.06	+.18	+.12	+.14	+.09	+.13

TABLE 1.—Solar radiation intensities during April 1940—Continued

BLUE HILL, MASS.

Date	Sun's zenith distance										Local mean solar time
	7:30 a. m.	78.7°	75.7°	70.7°	60.0°	0.0°	60.0°	70.7°	75.7°	78.7°	
	75th mer. time										
e	5.0	4.0	3.0	2.0	1.0	2.0	3.0	4.0	5.0	e	
m.m.	cat.	cat.	cat.	cat.	cat.	cat.	cat.	cat.	cat.	m.m.	
Apr. 6	2.2	0.94	1.02	1.12	1.28	1.44	—	—	—	2.8	
Apr. 7	2.0	1.00	1.09	1.21	1.35	1.54	1.32	0.88	0.50	1.6	
Apr. 10	3.6	.75	.87	1.06	1.21	1.47	1.25	1.08	.96	2.8	
Apr. 11	4.0	.89	.97	1.09	1.25	1.43	—	—	—	2.9	
Apr. 14	2.0	.84	.97	1.08	1.24	1.48	—	—	—	1.5	
Apr. 15	2.6	.89	.99	1.11	1.26	1.40	—	—	—	2.5	
Apr. 19	5.6	—	—	—	—	—	1.38	—	—	4.6	
Apr. 26	5.2	.78	.88	1.03	1.26	1.46	—	—	—	4.4	
Apr. 28	3.0	.81	.92	1.06	1.26	1.49	1.28	1.10	.98	2.8	
Apr. 29	3.0	—	—	—	—	—	1.03	.84	.70	.61	
Means	—	.86	.96	1.10	1.26	1.45	1.22	1.01	.88	.78	—
Departures	—	-.01	.00	-.06	+.06	+.06	+.09	+.01	-.02	+.04	—

¹ Extrapolated.² Partial eclipse; not used in obtaining means.

LATE DATA

BLUE HILL, MASS.

Mar. 1	2.2	—	—	—	—	—	—	—	—	0.89	0.81	0.72	3.0
Mar. 2	1.5	.96	1.07	1.18	—	—	1.44	1.39	1.14	1.07	.93	2.5	
Mar. 8	2.8	—	—	—	—	—	—	—	—	—	—	3.2	
Mar. 9	3.0	.78	.88	1.03	1.23	1.45	1.26	1.11	.97	.81	3.5		
Mar. 10	2.2	.87	1.03	1.18	1.33	1.44	1.25	—	.99	.91	2.1		
Mar. 11	1.5	.99	1.08	1.21	1.37	1.55	1.39	1.24	1.08	1.04	1.6		
Mar. 12	1.0	1.05	1.14	1.30	1.41	1.58	1.40	1.23	1.12	.98	1.8		
Mar. 13	1.3	1.02	1.11	1.22	1.35	1.53	1.32	1.13	1.00	.91	1.9		
Mar. 15	5.2	.72	.87	1.00	1.17	1.36	—	—	—	—	6.1		
Mar. 17	2.6	—	—	—	—	—	1.23	—	—	—	2.9		
Mar. 18	2.1	.94	1.01	1.11	1.24	1.39	—	—	—	—	2.5		
Mar. 19	4.6	1.00	1.10	1.19	1.32	1.46	1.30	1.16	1.04	.95	5.0		
Mar. 21	2.3	—	—	—	—	—	—	—	—	—	2.2		
Mar. 23	1.1	.97	1.05	1.20	1.36	1.53	—	—	—	—	1.2		
Mar. 24	1.1	—	—	—	—	—	1.27	1.50	1.35	1.18	1.05	1.3	
Mar. 25	1.3	—	—	—	—	—	1.34	1.47	—	—	—	1.5	
Mar. 26	2.0	.94	1.04	1.16	—	—	1.56	1.34	1.10	.98	.90	2.4	
Means	—	.93	1.03	1.15	1.29	1.48	1.33	1.13	1.01	.91	—	—	
Departures	—	+.04	+.06	+.06	+.06	+.05	+.10	+.07	+.05	+.05	+.05	—	

TABLE 2.—Average daily totals of solar radiation (direct + diffuse) received on a horizontal surface
 [Gram-calories per square centimeter]

Week beginning—	Washington	Madison	Lincoln	Chicago	New York	Fresno	Albuquerque	La Jolla	Miami	New Orleans	River-side	Blue Hill	New-port	Friday Harbor	Cambridge
Apr. 1.....	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.	cal.
418.....	343	433	350	437	531	478	507	525	376	439	449	467	410	436	
Apr. 8.....	314.....	404	522	270	368	581	713	-----	490	540	318	353	457	329	
Apr. 15.....	166.....	526	487	377	143	593	585	-----	499	362	554	233	271	496	224
Apr. 22.....	458.....	459	249	498	498	537	575	487	450	406	305	417	436	387	433

DEPARTURES FROM WEEKLY NORMALS

Apr. 1	+49	-26	+23	+57	+110	+11	-----	-15	+58	-4	-45	+71	+67	+70	-----
Apr. 8	-80	+2	+77	+70	+38	+7	-----	+16	+93	+52	-23	-49	-127	-127	-----
Apr. 15	-247	+127	+34	+40	-208	-3	-----	+20	-63	+22	-139	-135	-135	-135	-----
Apr. 22	+12	+25	-189	+129	+82	-36	-----	-24	+27	+11	-153	-26	-20	-97	-----

ACCUMULATED DEPARTURES ON APR. 29, 1940

$$-679 + 1,512 - 3,794 + 1,365 + 2,842 - 2,037 \dots - 1,540 + 2,674 + 1,841 - 3,339 + 840 - 126 + 2,821 \dots$$

LATE DATA

The mean daily total solar and sky radiation in gram-calories per square centimeter received on a horizontal surface at Fairbanks for the weeks beginning Feb. 26, March 4, 11, 18, and 25 are respectively 143, 153, 154, 305, and 279, with corresponding departures +3, -8, -45, +96, and -11. Similar means for Miami and for the above dates are, respectively, 478, 418, 375, 498, and 408, with corresponding departures +92, +33, -41, +35, and -48.

POSITIONS AND AREAS OF SUN SPOTS

POSITIONS AND AREAS OF SUN SPOTS—Continued

[Communicated by Capt. J. F. Hellweg, U. S. Navy (Ret.), Superintendent, U. S. Naval Observatory. Data from measurements at the U. S. Naval Observatory from plates obtained at the observatories indicated. Difference in longitude is measured from the central meridian, positive toward the west. Latitude is positive toward the north. Areas are corrected for foreshortening and expressed in millions of Sun's hemisphere. For each day below longitude, latitude, area of spot or groups, and spot count, are given, respectively, the assumed longitude of the center of the disk, assumed latitude of the center of the disk, total area of spots and groups, and total spot count]

Date	East- ern stand- ard time	Mount Wil- son group No.	Heliographic				Area of spot or group	Spot count	Plate qual- ity	Observatory
			Dif- fer- ence in longi- tude	Lon- giti- ude	Lat- itude	Dis- tan- ce from cen- ter of disk				
1940 Apr. 1 ...	h. m. 13 33	(*) 6799 6794 6795 6792 6792 6786 6784	°	°	°	°	12 85 218 24 48 194 194 242	1 5 1 7 7 10 1 1	G	U. S. Naval
			-59	352	-19	59				
			-54	357	-16	54				
			-8	43	-12	10				
			-4	47	-11	5				
			+11	62	+7	17				
			+19	70	+7	24				
			+49	100	-5	49				
			+75	126	+11	77				
				(51)	(-7)		1,017	33		
Apr. 2 ...	14 26	6800 6799 (*) 6794 6795 6792 6792 6796 6786	-58	339	+8	61	6 40 5 10 11 27 35 47 62	3 15 8 10 4 9 11 5 1	G	Do.
			-39	358	-15	40				
			+5	42	-4	5				
			+7	44	-12	10				
			+10	47	-11	11				
			+23	60	+8	27				
			+32	69	+8	35				
			+39	76	+20	47				
			+62	99	-5	62				
				(37)	(-6)		773	66		
Apr. 3 ...	10 51	6800 6801 6799 6798 6794 6795 6792 6796 6786	-44	342	+8	49	12 38 30 36 20 21 48 24 194	5 73 73 12 20 21 48 24 194	VG	Mt. Wilson
			-38	348	-7	38				
			-28	358	-15	30				
			-19	7	+24	36				
			+19	45	-12	20				
			+21	47	-11	21				
			+44	70	+8	48				
			+52	78	+20	59				
			+74	100	-5	74				
				(26)	(-6)		823	41		
Apr. 4 ...	11 3	6801 6799 6794 6794 6795 6792 (*)	-25	347	-7	25	170 18 31 32 34 61 85 12	14 11 1 24 24 6 7 4	G	U. S. Naval
			-16	356	-15	18				
			+31	43	-12	31				
			+31	43	-14	32				
			+34	46	-10	34				
			+58	70	+8	61				
			+80	92	+12	82				
				(12)	(-6)		630	48		

Date	East- ern stand- ard time	Mount Wil- son group No.	Heliographic				Area of spot or group	Spot count	Plate qual- ity	Observatory	
			Dif- fer- ence in longi- tude	Lon- gi- tude	Lat- i- tude	Dis- tan- ce from cen- ter of disk					
Apr. 5---	11 44	6804	o	o	o	o	48	1	F	U. S. Naval.	
		6801	-85	274	-10	85					
		6801	-13	346	-7	13					
		6801	-9	350	-8	10					
		6799	-3	356	-15	10					
		(*)	-3	356	-11	6					
		6803	+8	7	-6	8					
		6794	+45	44	-11	45					
		6795	+48	47	-10	48					
		6792	+71	70	+8	75					
Apr. 6---	11 8		(359) (-6)				732	41	G	Do.	
		6803	-75	271	-10	75					
		6801	0	346	-7	1					
		6799	+1	347	-15	10					
		6801	+5	351	-8	5					
		6799	+10	356	-15	13					
		6803	+22	8	-6	22					
		6794	+58	44	-12	58					
			(346) (-6)				896	33	F	Do.	
			(346) (-6)								
Apr. 7---	12 30		6803	-68	284	-10	68	73	9	F	Do.
			6803	-53	279	-10	53	145	4		
			6804	-40	292	+19	48	12	2		
			6801	+14	346	-7	14	48	4		
			6501	+20	352	-9	21	194	1		
			6799	+23	355	-16	25	73	6		
			6794	+71	43	-12	71	242	1		
			(332) (-6)				787	27	VG	Mt. Wilson.	
			(332) (-6)								
Apr. 8---	10 58		6803	-43	277	-9	43	145	10	VG	Mt. Wilson.
			6805	-43	277	+22	51	48	3		
			6805	-40	280	+20	49	73	3		
			6801	+34	354	-9	34	145	3		
			6799	+37	357	-17	39	48	3		
			6802	+49	9	-8	49	24	2		
			6794	+85	45	-12	85	242	1		
			(320) (-6)				725	25	G	U. S. Naval.	
			(320) (-6)								
Apr. 9---	13 40		6808	-86	210	-12	86	12	1	G	U. S. Naval.
			6805	-30	275	+22	42	36	4		
			6803	-20	278	-9	29	97	3		
			6805	-26	279	+20	37	48	9		
			6807	+42	347	+8	45	73	7		
			6801	+48	353	-8	48	97	3		
			6806	+50	355	+7	53	12	3		
			6801	+54	359	-7	54	6	1		
			6802	+63	8	-7	63	6	1		
			(305) (-6)				387	32	G	U. S. Naval.	

See notes at end of table.